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Research Article

Smart learning management: Key factors in implementing practical project in schools

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ABSTRACT

Smart learning management in schools refers to the integration of various elements designed to enhance learning experiences, promote student engagement, and support improved educational outcomes. This study aimed to examine key factors associated with the implementation of smart learning management in practical projects conducted in schools participating in a smart learning initiative through collaboration between a university and partner schools. The research employed a quantitative cross-sectional survey design involving school administrators and teachers from schools under the Secondary Education Service Area Office in four northeastern provinces of Thailand: Khon Kaen, Udon Thani, Ubon Ratchathani, and Nakhon Ratchasima. Data were collected through questionnaires from 72 school administrators and 79 teachers. The findings indicate that several dimensions are perceived as important for the implementation of smart learning management, including executive leadership, teacher readiness and motivation, policy and promotional support, and student readiness and motivation. The results also highlight the importance of comprehensive school preparation, such as clear policies, adequate technological infrastructure, supportive learning environments, and effective school management. These findings provide insights into key conditions that support the implementation of smart learning initiatives and may help guide schools and policymakers in strengthening smart learning practices in educational settings.

Keywords: smart learning, learning ecology management, secondary schools, education administrators, schoolteachers

INTRODUCTION

Smart learning transforms education by integrating formal and informal learning to provide a flexible, adaptive, and personalized environment that offers real-time support to each learner (Kinshuk et al., 2016).

At its core, a smart learning environment combines advanced technologies with adaptive teaching to provide personalized learning experiences. It fosters engagement and collaboration while supporting flexible learning paths and the development of critical thinking and practical skills (García-Tudela et al., 2021; Yusufu & Nathan, 2020). It supports learner independence through self-directed, flexible learning and ongoing evaluations. With the use of technologies like AI and data analytics, smart learning provides customized content and fosters collaborative learning. This strategy enhances learning outcomes and helps develop vital skills such as critical thinking, problem-solving, and digital literacy, preparing learners for success in a digital-driven world. Moreover, teachers in a smart learning environment can design technology integration activities independently or through teamwork with others (Singh, 2022).

Previous studies noted that the readiness of factors concerning the learning environment, devices, accessibility, facilities, learning ability, and communication skills significantly contribute to the implementation of virtual learning through providing students with necessary resources and experiencing online learning. Other factors such as teaching, support, learner, technology, pedagogy, and environmental dimensions are key factors of smart learning (Bates, 2022; Bhatt et al., 2021). In addition, national educational policies, objectives, and curriculum, school education strategies, social needs, and competency frameworks also impacted to develop learners' knowledge, skills, and attitudes (Nguyen et al., 2023).

The study of Bećirović (2024) indicated that information quality has a significant effect on both output and system quality, and that output quality affects perceived usefulness. However, system quality does not significantly influence perceived usefulness or system success. To boost the implementation of a learning management system, it is crucial to improve content, system, and output quality to enhance student satisfaction and perceived usefulness. According to Wilson et al. (2021), the capacity of human resources has a conditional indirect effect on smart education, which is mediated through leadership capacity. This means that the impact of human resources on the implementation of smart education is not direct but is significantly influenced by the quality and effectiveness of leadership. Additionally, Chuaphun and Samanchuen (2024) identified 10 key factors that influence virtual learning, including technology, management, learning capability, pedagogy, resource support, ethical considerations, institutional factors, interface design, evaluation, and environmental factors.

The Smart Learning Innovation Research Center (SLIRC) at Khon Kaen University (KKU), Thailand, launched in 2016, aims to develop digital learning innovations to enhance students' competencies across content, pedagogy, and learning environments suited to their learning styles (Tuamsuk, 2019). The project targets students in grades seven to nine in Northeastern Thailand on mathematics, science, and English subjects, focusing on innovative teaching strategies aligned with national and international educational standards and tests, such as science, technology, engineering, and mathematics, the Common European framework of reference for languages, and the OECD's program for international student assessment. The approach prioritizes understanding and the application of knowledge through technology, while also supporting teachers in improving their pedagogical skills and integrating digital tools to create effective learning environments. The implementation of the project has been done under the cooperation of management between the schools' teachers and administrators, the administrators of educational authority organizations in the region, and the university faculty members and researchers (Tuamsuk, 2019). Since the project has been conducted for many years, it is important to investigate the management of the project, especially the related factors of the smart learning project implementation.

This study aims to examine stakeholders' perceptions of key factors associated with the implementation of smart learning management in schools participating in the project of SLIRC. The findings provide valuable insights for school administrators, teachers, and other stakeholders by identifying key factors that impact the implementation of smart learning management. For administrators, the study supports data-driven decision-making, effective policy planning, improved leadership practices, and the establishment of essential conditions for managing smart learning environments. Teachers gain a clearer understanding of potential challenges, support needs, and professional development opportunities, along with strategies for integrating technology and enhancing motivation. Additionally, policymakers and educational technology providers can use these insights to refine policies, allocate resources, and develop tailored solutions, ultimately supporting a more effective and sustainable smart learning ecosystem.

LITERATURE REVIEW

This section reviews relevant literature on factors related to the implementation of smart learning management. The findings from this review provided the basis for developing questionnaire items addressing various aspects of smart learning management. Based on the literature, five key factors associated with the management of smart learning were identified as follows:

Policy and Promotional Support

Transformative policies are integrated, aligned, and designed for action and sustainability, with a focus on reforms that protect students, ensure data privacy, and foster technological advancements in education. Policymakers must articulate a clear vision, create a detailed plan, implement initiatives, and evaluate and adjust them as needed. Flexible policies at various levels - national, state, and school - should collaborate to support innovation and empower teachers to use information and communication technology (ICT) to improve learning and teaching (Aas et al., 2020; Price, 2015).

The study of Kong et al. (2014) mentioned that policies in schools have transformed significantly across five core areas. Infrastructure has shifted from basic facilities to advanced digital platforms. In curriculum integration, there has been a move from teacher-centered approaches to student-driven learning supported by mobile technology for developing 21st century skills. The focus on students' learning has evolved from teacher-led integration to enhancing students' ability to actively engage with e-Learning. Teacher professional development now emphasizes collaborative peer support rather than solely skill-based training. Lastly, leadership and capacity building prioritize school-based contributions, peer training, and parental involvement instead of relying solely on government-driven research (Aas & Vennebo, 2023; Kong et al., 2014). Thus, these findings underscore the importance of leadership and capacity-building efforts in creating the foundation and conditions necessary for the implementation of smart learning management systems.

Executive Leadership

Price (2015) indicated that school leadership is structured across three levels: the macro level, focusing on national and provincial policy; the meso level, managing school-specific decisions; and the micro level, emphasizing classroom leadership. Regarding this, principals are essential in enabling or hindering the integration of innovative teaching and technology. Their support is critical for empowering teachers and sustaining educational innovation. The leadership needed to implement project-based learning, which is technology-driven, student-centered, and challenges traditional teaching structures. Additionally, Wang et al. (2021) emphasized that smart education frameworks exclude leadership as a key construct, undermining the contribution of governing bodies and school administrations in driving smart education. This exclusion implies a lack of formal guidance for teachers (Zhu et al., 2016).

Other studies mentioned that leadership is critical in smart transformation, driving change through awareness, motivation, and strategic readiness. Effective leaders align smart education initiatives with institutional goals, foster collaboration, and create environments conducive to innovation. Approaches like top-down or bottom-up vary in implementation, but leadership's role in overcoming resistance and encouraging technology adoption remains central (Lee & Trimi, 2018; Price, 2015; Sá & Serpa, 2020). In addition, school leaders play a significant role in developing schools, with change processes depending on their capacity to lead collective learning through collaborative and reflexive activities. Furthermore, involving various stakeholders, including teachers, families, and community members, in leadership development is essential for fostering a culture of collaboration and shared responsibility (Aas & Vennebo, 2023).

Thus, it is important to outline three important roles of school-level leadership in promoting ICT integration and pedagogical innovation. Firstly, leadership is not limited to the principal; teacher leaders and other administrators also play a key role in advocating for ICT-focused professional development. Secondly, leadership starts with setting a clear vision and expectations for teachers, followed by continuous support in the classroom, especially as many teachers were unfamiliar with the new methods. Finally, strong leadership includes addressing logistical issues like limited resources, with administrators finding innovative solutions to facilitate change and progress (Price, 2015). It is noted that executive leadership influences the implementation of smart learning management by providing vision, motivation, and strategic support at

multiple levels, empowering teachers, fostering collaboration, overcoming resistance to change, and ensuring the effective integration of technology and innovative pedagogies within schools.

Technology and Digital Learning Environments

Technology plays a central role throughout the learning process, while management is essential in the early stages, transitioning from administrative to learner-centered approaches (Kyambade et al., 2025; Wong & Li, 2025). Learning capability becomes crucial during core phases, promoting active engagement and knowledge application (Chuaphun & Samanchuen, 2024; Rohmaniyah & Asih, 2024). Pedagogy and resource support help ensure initial engagement leads to deeper understanding (Khodadad, 2023). Interface design enhances interaction at key moments, and evaluation focuses solely on measuring learning outcomes (Kishabale, 2021; Luo, 2024). Environmental factors encourage engagement and exploration, contributing to overall learning success (Chuaphun & Samanchuen, 2024). Additionally, they highlighted technology and management as crucial factors for virtual learning. They emphasized the importance of effective technological design and management policies in building a supportive virtual learning environment, providing strategic recommendations to educational leadership teams for policy development and offering support to both learners and instructors (Chuaphun & Samanchuen, 2024).

According to Price (2015), educational technologies in smart learning environments empower educators to tailor instruction, refine assessments, and offer authentic learning opportunities. They achieve this by combining devices, quality software, reliable internet, secure cloud services, and a solid infrastructure to enrich classroom experiences (Singh, 2022). In addition, education can be viewed as a spectrum, ranging from traditional face-to-face instruction enhanced by technology to blended-learning strategies that integrate digital tools at various levels, to technology-driven education where digital platforms are central to communication and learning (García-Tudela et al., 2021). Therefore, technology and the digital learning environment significantly contribute to the implementation of smart learning management by providing the essential tools, infrastructure, and supportive policies that enable personalized, engaging, and ethically guided learning experiences, while fostering active student participation and effective instructional practices.

Readiness and Motivation for Teachers

Previous studies mentioned that teachers demonstrated key changes in their attitudes, knowledge, and actions, including a transformation in their beliefs about student learning, a stronger understanding of new instructional methods, changes in how students engaged with learning, and more effective use of ICT to support education. These shifts enhanced classroom management, access to resources, and student engagement with tasks (Light & Pierson, 2012). In addition, trust in teachers' readiness for change, as well as trust in leaders and colleagues, is essential for successful organizational change. Confidence in leaders ensures that changes are fair, beneficial, and achievable, particularly when they provide updates, involve staff, and act justly. In addition, attitudes with students and trust among colleagues fosters collaboration, commitment, and positive relationships, which encourages a greater willingness to embrace change within schools (Denessen et al., 2022; Kondakci et al., 2017). Tyan et al. (2020) emphasized that teacher readiness regarding the use of multimedia in teaching, including their knowledge, skills, and attitudes, plays a crucial role in improving the quality of teaching and learning in schools.

Additionally, the integration of technology in education transforms teaching and learning by shifting from teacher-centered to student-focused approaches. It meets societal demands for modern education while fostering active participation, curiosity, and intrinsic motivation through innovative methods and problem-solving activities. Technology supports autonomy and collaboration, particularly in e-learning, redefining roles as students become active learners and teachers act as facilitators. By creating engaging and proactive environments, digital tools enhance knowledge retention, motivate learners and educators, and drive the adoption of innovative methodologies that improve educational outcomes (Gómez-Trigueros et al., 2024). Thus, teachers' readiness and motivation factors could influence the implementation of smart learning management by fostering positive attitudes, enhancing instructional skills, building trust and collaboration among staff, and enabling effective integration of technology that transforms teaching into a more student-centered, engaging, and innovative learning experience.

Readiness and Motivation for Students

Learning motivation, the ability to initiate and sustain learning behavior toward academic goals, plays a crucial role in enhancing students' higher-order thinking skills. Previous studies have shown that high motivation positively impacts creativity and directly influences thinking skills, especially in smart classroom environments (Lu et al., 2021; Schweder & Raufelder, 2024). Motivation plays a key role in learning and is closely related to academic success. In smart and student-centered classrooms, motivated students actively interact, collaborate, and learn from each other. This dynamic participation fosters creativity, critical thinking, and problem-solving skills, reducing the need for constant teacher guidance (Liu et al., 2024).

Chun (2021) emphasized that to enhance students' learning motivation, teachers should provide technical support and instructional strategies, create competitive and collaborative tasks to build self-efficacy, and design activities that offer deeper learning experiences. These experiences should gradually increase motivation while fostering confidence and satisfaction through active engagement. Activities involving communication, collaboration, and creative problem-solving (Chen et al., 2018) are particularly effective. Furthermore, factors such as curriculum perception, design, and learning need significantly influence students' willingness to adopt blended learning (Zhang et al., 2020). In addition, learning processes experienced by learners have a positive influence on attaining knowledge (Lee, 2020). Therefore, student readiness and motivation are critical to the implementation of smart learning management because motivated students actively engage, collaborate, and apply higher-order thinking skills in student-centered environments, which enhances creativity, critical thinking, and independent learning while reducing reliance on teacher guidance.

Although previous studies have identified several factors related to smart learning, such as technology, pedagogy, institutional support, and leadership, many studies focus on these elements separately or emphasize technological aspects of learning systems. There is still limited research examining the combined roles of organizational, technological, and human factors in the practical implementation of smart learning management in schools. In addition, few studies have explored the perceptions of key stakeholders, particularly school administrators and teachers, regarding the conditions that support smart learning initiatives in real educational contexts. Therefore, this study examines stakeholders' perceptions of key factors associated with the implementation of smart learning management in schools participating in the SLIRC project in four provinces of Northeastern Thailand.

METHOD

Sampling

This paper contributes to the project 'Smart learning innovation and model for the advancement of learners' competencies in digital environments,' which is dedicated to enhancing learners' skills across digital learning platforms in four provinces in Thailand: Khon Kaen, Udon Thani, Ubon Ratchathani, and Nakhon Ratchasima.

The primary objective of this research is to examine participants' perceptions of key factors associated with the implementation of smart learning management. The target groups for this study include administrators, and teachers from the Secondary Education Service Area Office (SESAO) in the four aforementioned provinces, all of whom participated in the SLIRC.

As for the administrator's group, a purposive sampling method was employed to ensure the inclusion of individuals with relevant leadership roles across different administrative levels. The selection was divided into two main categories. The first group consisted of provincial-level administrators, including executive directors and school supervisors responsible for overseeing educational policy and management within the province. The second group comprised school-level administrators, such as school principals and vice principals, who are directly involved in managing the day-to-day operations of schools. This two-tiered approach allowed the study to capture perspectives from both strategic and operational levels of educational administration, offering a more comprehensive understanding of the factors associated with the implementation of smart learning initiatives.

With regards to the teachers, data were collected from those teaching three core subjects, including mathematics, science, and English at the lower secondary level (grade 7 to grade 9). Teachers participating in this study were from schools under the SESAO within these provinces. All participants had also taken part in the SLIRC initiative, ensuring their direct involvement in digital education practices. By focusing on these educators, the study seeks to gain insights into the real-world implementation of smart learning and the factors that contribute to its implementation in varied educational settings.

A questionnaire was distributed to all target participants to gather as much detailed information as possible, ensuring comprehensive insights into the factors associated with the implementation of smart learning management.

Research Instrument

This study employed a quantitative research approach, utilizing a structured questionnaire to collect data from participants. The questionnaire was designed based on an extensive review of previous research presented in the literature review section. Its structure includes three main parts: demographic information, key factors in implementing smart learning management, and participants' additional opinions in the management of smart learning.

Part 1. Demographic information: This section includes multiple-choice questions aimed at gathering respondent characteristics to provide context for their responses.

Part 2. Key factors in implementing smart learning management: This section consists of questions on a four-point Likert scale (from 1 = strongly disagree to 4 = strongly agree), focusing on participants' perceptions of five key factors associated with the implementation of smart learning management, such as policy and promotional support (5 items), executive leadership (5 items), technology and digital learning environment (5 items), teacher readiness and motivation (11 items), student readiness and motivation (5 items). Each set of questions in this section is designed to capture specific insights into how these factors in relation to the implementation of smart learning management in schools.

Part 3. Open-ended question: In this final section, participants are invited to provide additional comments or perspectives on other factors related to the implementation of smart learning management in schools. This open-ended format allows respondents to share further insights and elaborate on the structured responses provided in part 2.

To ensure the quality and reliability of the questionnaire, we sent the tool to three experts with extensive experience in smart learning for validation. They reviewed the structure, content, and language of the questionnaire to assess its clarity, relevance, and alignment with the study's objectives. Based on their feedback and recommendations, we revised the relevant sections, refining both the content and wording to enhance their effectiveness and accuracy. This process ensured that the questionnaire met high standards of validity and comprehensibility before being distributed to participants.

Data Collection

The final version of the questionnaire was created using Google Forms for ease of distribution and data collection. To facilitate participant access, we generated a QR code that linked directly to the form. The data collection process was carried out by sending the QR code to participants through various channels, including email, Line, Facebook, and via project coordinators across different provinces. This multi-platform approach ensured wide reach and convenience for participants, allowing them to easily complete the questionnaire at their convenience. This process took approximately five months, from September 2024 to January 2025. However, due to limitations in the number of participants, researchers, and time constraints, we collected 151 questionnaires, including 72 from administrators and 79 from teachers.

Data Analysis

Following the data collection, we conducted a thorough data cleaning process to ensure the quality and reliability of the responses. This involved reviewing the completed questionnaires to identify and remove any that were incomplete, inconsistent, or improperly filled out. The cleaned data was then prepared for analysis, ensuring that only valid and complete responses were included in the study.

Table 1. Demographic data of the respondents

Respondents' data	Teachers		Administrators	
	N (79)	100%	N (72)	100%
Education				
Bachelors' degree	52	65.8	7	9.7
Master's degree	22	27.8	54	75.0
Doctoral degree	5	6.4	11	15.3
Teaching/service experiences (years)				
Less than 20	-	0.0	3	4.1
21-30	15	19.0	1	1.4
31-40	24	30.4	19	26.4
41-50	24	30.4	28	38.9
51-60	16	20.2	21	29.2
Taught subject				
Science	24	30.4	-	-
Mathematics	33	41.8	-	-
English language	22	27.8	-	-

Next, the data were analyzed using SPSS to examine participants' demographic characteristics and their perceptions of the key factors associated with the implementation of smart learning management. Descriptive statistics, including frequencies, means (M), and standard deviations (SD), were used to describe the distribution of demographic variables and summarize respondents' perceptions of each factor. In addition, exploratory factor analysis (EFA) was employed only to assess the validity and reliability of the research instrument. Because the five-factor framework of smart learning management had already been established from previous literature, the purpose of the EFA was not to identify new factors, but to determine whether the collected data supported the proposed factor structure. The results showed that the items loaded appropriately onto their respective factors, thereby providing evidence of construct validity, while reliability was assessed through the internal consistency of each factor.

RESULTS

Demographic Data of the Respondents

The data collection process yielded 79 responses from teachers and 72 from administrators, which were used for data analysis. Demographic data of the respondents are presented in **Table 1**.

Among the teachers surveyed, a majority–65.8% held a bachelor's degree, while 27.8% held a master's degree, and 6.4% held a doctoral degree. In terms of teaching experience, the largest participants fell within 41-50 and 31-40 years, each making up 30.4% of the group. These were followed by 51-60 years at 20.2%, and 21-30 years at 19.0%. Among the subjects taught by the teachers in the study, mathematics had the highest representation, with 41.8%, followed by science at 30.4%, and English language at 27.8%.

Within the administrator group, the most experienced individuals–those with 41-50 years of service, made up the largest portion at 38.9%. This was followed by 51-60 years at 29.2%, 31-40 years at 26.4%, those with less than 20 years at 4.1%, and a small portion at 1.4% with 21-30 years of experience. Regarding educational qualifications, most administrators at 75.0% held master's degrees. This was followed by 15.3% with doctoral degrees and 9.7% with bachelor's degrees.

Validity and Reliability of the Instrument

Before presenting the substantive findings, the instrument's validity and reliability were evaluated. The appropriateness of the data for factor analysis was initially determined using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. The results in **Table 2** show that the 80.4% explained variance suggests that the retained items play a crucial role in the model's explanatory capacity. As per Kaiser (1974), a KMO value greater than 0.50 indicates the adequacy of data for factor analysis. In this study, the KMO value of 0.938 demonstrates a strong relationship between variables, confirming the dataset's suitability for confirmatory factor analysis. Additionally, Bartlett's test of sphericity yielded a statistically significant result ($p < 0.001$), ensuring that the correlation matrix meets the criteria for factor analysis.

Table 2. KMO and Barlett's test

Variable	Value
KMO measure of sampling adequacy	.933
Barlett's test of sphericity approximate Chi-square	5,649.460
df	325
Significance	< .001

Table 3. Reliability and construct validity of the five factors

No	Factors	Number of items	Cronbach's alpha	Factor loading
1	Policy and promotion support	5	0.956	0.723
2	Executive leadership	5	0.964	0.617
3	Technology and digital learning environment	5	0.953	0.713
4	Readiness and motivation for teachers	11	0.977	0.668
5	Readiness and motivation for students	5	0.943	0.740

Next, the reliability and construct validity of the measurement scale were evaluated. As shown in **Table 3**, the Cronbach's alpha values revealed the internal consistency of the survey items for each factor. All values exceed 0.90, which suggests excellent reliability. The highest reliability is observed in readiness and motivation for teachers (0.977), indicating a strong consistency in how this factor is measured. The lowest reliability, though still very high, is found in readiness and motivation for students (0.943). These values refer to the overall reliability of each factor, calculated from all items within that factor. These results confirm that the questionnaire effectively captures the underlying dimensions of smart learning management.

In terms of factor loadings, they measure the correlation of each factor with the overall construction of smart learning management. Principal component analysis with Varimax orthogonal rotation and Kaiser normalization was used to examine the construct validity of the measurement items. Items in each factor were retained based on commonly accepted criteria, including eigenvalues greater than 1.0 and factor loadings above 0.50, indicating a strong association between the items and their respective factors. Factor loadings represent the strength of the relationship between each item and the underlying construct.

As a result, all factors have loadings above 0.60, confirming their strong association. The highest factor loading is observed for readiness and motivation for students (β = 0.740), indicating that student engagement plays a significant role in smart learning implementation, followed by policy and promotion support (β = 0.723), technology and digital learning environment (β = 0.713), and readiness and motivation for teachers (β = 0.668). Executive leadership (β = 0.617) has the lowest factor loading, though it remains within an acceptable range.

Key Factors in the Implementation of Smart Learning Management

As presented in **Table 4**, the results show that the respondents generally rated the factors at a moderate to high level influencing the implementation of smart learning management, with M scores ranging from 3.39 to 3.53. Among the five factors, executive leadership received the highest M score (M = 3.53), while technology and the digital learning environment had the lowest M score (M = 3.39). The standard deviations, ranging from 0.679 to 0.740, indicate a moderate level of variation in participants' responses.

Table 4. M and SD values of factors in the implementation of smart learning management

No	Factors	M	SD
1	**Policy and promotion support**	**3.42**	**0.683**
1.1	Develop a comprehensive strategic plan covering the organization structure, resources, and network infrastructure that supports smart learning management	3.44	.680
1.2	Supervise and support the management of the learning ecosystem that is necessary for the school, such as identifying stakeholders and those involved in the school, managing internal problems, issuing regulations that support teaching and learning, responding between administrators, teachers and students, and resolving complaints	3.42	.678
1.3	Technology and teaching methods that support the use of smart learning innovations in a concrete manner to enhance teachers' abilities	3.42	.696
1.4	Monitoring the performance of the digital learning ecosystem that supports smart learning according to the plan and the achievement of the school's strategic goals, and reporting the results for development, improvement and correction	3.41	.695

Table 4 (Continued).

No	Factors	M	SD
1.5	Internal and external environments are analyzed to identify strengths and weaknesses in dealing with changes to the new digital learning system	3.40	.666
2	**Executive leadership**	**3.53**	**.679**
2.1	The executives see the benefits of management that will lead to the implementation of the platform in academic and teaching development in the modern learning ecosystem	3.57	.648
2.2	The administrators are open-minded and able to communicate with teachers in the school about the implementation of the platform in the school and coordinate with the research center	3.53	.691
2.3	The administrators have a vision to implement learning models and innovations in schools	3.52	.662
2.4	The administrators supervise, monitor and evaluate the implementation of smart teaching and learning innovation models in schools	3.51	.692
2.5	Executives appropriately addressed the management issues that arose	3.50	.701
3	**Technology and digital learning environment**	**3.39**	**.722**
3.1	The school designs and plans to support readiness in using digital technology that supports smart learning	3.46	.671
3.2	The school clearly and effectively sets guidelines for using technology to manage smart teaching in the classroom, such as content management, teaching methods, learning activities and promoting learning through digital technology	3.44	.689
3.3	The school has an internet system that supports fast and efficient access to content and learning media within the school	3.39	.730
3.4	Teachers and students have technological devices that can be used effectively in teaching and learning. They can access information from various sources, both in the form of websites and applications	3.36	.742
3.5	The school has prepared other facilities such as smart classrooms, meditation rooms, and learning centers that are fully equipped with technology	3.32	.779
4	**Readiness and motivation for teachers**	**3.49**	**.685**
4.1	Promote the use of technology in teaching by explaining the concept of the content that is taught to students so that they understand more than memorizing	3.54	.640
4.2	Promote the use of technology to teach problem-based learning to practice analytical thinking skills, problem solving skills, and self-directed learning	3.52	.662
4.3	Promote the use of technology in teaching in a way that stimulates learners' learning (active learning) by allowing learners to participate in learning by thinking, asking questions, and expressing opinions	3.52	.662
4.4	The school promotes the organization of training, encourages teachers to participate in teacher training and evaluates teacher training after participation	3.51	.652
4.5	There is a clear plan for teaching and learning objectives	3.50	.779
4.6	Promote the use of technology in teaching in an inquiry-based learning format that aims to develop systematic learning skills based on scientific methodology	3.50	.672
4.7	Promote the use of technology in learning management through activities (task-based learning) so that learners can practice and complete tasks according to the set goals	3.49	.662
4.8	There is promotion and encouragement for teachers in schools	3.48	.691
4.9	Promote the use of technology for experiential-based learning to enable learners to connect the content of the lesson to real situations or experiences	3.47	.710
4.10	The school controls, monitors and follows up on the use of technology in conjunction with teaching and learning	3.45	.690
4.11	The school facilitates the provision of technology and computers for organizing smart learning activities, such as group activities, creating chat rooms, and playing quiz games	3.44	.717
5	**Readiness and motivation for students**	**3.42**	**.740**
5.1	There are communication channels between teachers and students and students and students to students through online media or social networks for mutual learning to meet learning needs and achieve learning objectives	3.50	.672
5.2	In schools, a learning community atmosphere is fostered that is conducive to learning both in the classroom and in the digital environment	3.48	.691
5.3	Students are promoted in both learning spirit and learning motivation from smart learning	3.40	.792
5.4	Students are prepared by teachers in learning and innovation from KKU smart learning, including learning media, content, and online media on digital tools and learning devices	3.32	.796
5.5	Students are encouraged to participate in teacher-supervised learning activities (e.g. experiments, teamwork, discussions, presentations, homework) using learning content and technological platforms and tools to access websites, platforms, applications, and generate new ideas	3.39	.748

Table 4 also presents the M scores and standard deviations of individual items under the five factors influencing the implementation of smart learning management as follows:

Policy and promotion support

Of the five items, the highest M score was found for the development of a comprehensive strategic plan that addresses organizational structure, resources, and network infrastructure in support of smart learning management (M = 3.44). This was followed by supervision and support for managing the learning ecosystem, such as identifying stakeholders, handling internal issues, issuing regulations that support teaching and learning, facilitating communication among administrators, teachers, and students, and resolving complaints (M = 3.42). The item concerning technology and teaching methods that provide concrete support for smart learning innovation and enhance teachers' abilities received the same M score (M = 3.42). These findings suggest that respondents attached considerable importance to strategic planning, administrative support, and practical instructional guidance as key dimensions of policy and promotional support.

The item on monitoring the performance of the digital learning ecosystem in line with the plan and the school's strategic goals, and reporting the results for further development and improvement, received a slightly lower rating (M = 3.41). The lowest-rated item was the analysis of internal and external environments to identify strengths and weaknesses in adapting to changes in the new digital learning system (M = 3.40). These results indicate that respondents were somewhat less positive about the school's focus on systematic evaluation and strategic environmental analysis.

Executive leadership

Of the five sub-factors, the item with the highest rating was the administrators' recognition of the benefits of management in promoting the use of platforms for academic and instructional development (M = 3.57), whereas the lowest-rated item concerned executives' ability to deal appropriately with management issues that arose (M = 3.50). The small differences among the M scores suggest a consistent view that school leaders play an active and supportive part in promoting innovation. More specifically, leadership was perceived not only in terms of vision, but also through communication, coordination, supervision, and evaluation. These results indicate that executive leadership was considered an important enabling factor in turning smart learning policy into actual practice within schools.

Technology and digital learning environments

Among the five items related to technology and the digital learning environment, providing necessary facilities such as smart classrooms and learning centers has the lowest M score (M = 3.32). Access to devices for teachers and students was also rated comparatively lower (M = 3.36). These results suggest that while schools may have plans and guidelines for digital learning, the physical and technical conditions needed to fully support smart learning were perceived as somewhat less developed. On the other hand, designing and planning for digital technology readiness has the highest M (M = 3.46), followed by setting clear guidelines for technology use in classroom management (M = 3.44), suggesting that the school places considerable importance on preparing for digital technology integration, and it is highly correlated with the overall construct of smart learning readiness.

Readiness and motivation for teachers

Among the eleven items, the highest M score was recorded for encouraging the use of technology in teaching to help students gain a deeper understanding of concepts rather than depend on memorization (M = 3.54). This was followed by the use of technology to promote active learning (M = 3.52), problem-based learning (M = 3.52), and support for teacher training together with post-training evaluation (M = 3.51). Inquiry-based learning and the establishment of clear teaching and learning objectives were also rated relatively highly (M = 3.50). These results suggest that respondents gave particular importance to pedagogical practices that integrate technology in ways that foster deeper comprehension, learner engagement, critical thinking, and ongoing teacher development.

Other items were also viewed positively, including task-based learning (M = 3.49), promotion and encouragement for teachers within schools (M = 3.48), and experiential learning supported by technology (M = 3.47). This pattern indicates that respondents acknowledged a wide variety of technology-supported instructional strategies, particularly those that emphasize learner-centered approaches and connect lesson

Table 5. Stakeholders' perceptions of factors in the implementation of smart learning management

Factor	Position	M	SD	t-value	p-value
Policy and promotion support	Administrators	3.16	0.609	-5.269	0.001
	Teachers	3.66	0.554		
Executive leadership	Administrators	3.26	0.676	-5.341	0.001
	Teachers	3.77	0.480		
Technology and digital learning environment	Administrators	3.16	0.675	-4.283	0.001
	Teachers	3.60	0.583		
Readiness and motivation for teachers	Administrators	3.27	0.640	-4.479	0.001
	Teachers	3.70	0.507		
Readiness and motivation for students	Administrators	3.31	0.653	-1.898	0.060
	Teachers	3.52	0.674		

content with real-life experiences. It also suggests a favorable perception of schools' efforts to encourage teachers and strengthen their involvement in smart learning implementation. By comparison, the lowest-rated items were the provision of technology and computers for smart learning activities (M = 3.44) and the school's monitoring and follow-up of technology use in teaching and learning (M = 3.45). This implies that respondents were somewhat less satisfied with the institutional support mechanisms and material resources needed to maintain effective technology integration in teaching.

Readiness and motivation for students

Of the five items, the highest M score was given to the availability of communication channels between teachers and students, as well as among students, through online media or social networks for shared learning and the achievement of learning objectives (M = 3.50). This was followed by the presence of a learning community atmosphere that supports learning in both classroom and digital settings (M = 3.48). These results suggest that respondents attached particular importance to interaction, connectedness, and a supportive learning environment as key elements of student readiness for smart learning.

In contrast, the lowest-rated item was the preparation provided by teachers for students in relation to KKU smart learning innovations, including learning media, content, online media, digital tools, and learning devices (M = 3.32). Other relatively low-rated items were encouraging students to engage in teacher-supervised learning activities through technological platforms and tools (M = 3.39) and promoting students' learning spirit and motivation in smart learning contexts (M = 3.40). These findings indicate that respondents were somewhat less positive about the degree to which students were systematically prepared and motivated for smart learning through structured instructional support.

Overall, the item-level results indicate that respondents gave greater importance to leadership support, the instructional use of technology, and learning-related communication, whereas infrastructure and students' digital readiness received comparatively lower ratings. Furthermore, based on the results of open-ended questions, several teachers revealed several challenges and areas for improvement in implementing smart learning management in schools. Participants highlighted issues with the internet system, which occasionally causes disruptions in the learning process. They also suggested that sending books on time would significantly enhance the learning experience. Also, they expressed a lack of understanding regarding the use of the platform, pointing to the need for continuous development and ongoing support. Additionally, difficulties with remembering passwords were noted, suggesting that system accessibility could be improved. Despite these challenges, there is a strong emphasis on continuous development and follow-up on innovation to ensure that the system becomes more effective and user-friendly for all stakeholders involved.

Comparing stakeholders' perceptions of factors in the implementation of smart learning management

Table 5 shows the results of an independent samples t-test examining differences between administrators and teachers in their perceptions of factors influencing the implementation of smart learning management. The results indicate that teachers reported higher M scores than administrators across all examined factors. For policy and promotion support, teachers (M = 3.66) reported significantly higher perceptions than administrators (M = 3.16), t = -5.269, p < .001. Similarly, for executive leadership, teachers (M = 3.77) had significantly higher M scores than administrators (M = 3.26), t = -5.341, p < .001.

Significant differences were also found for technology and the digital learning environment, where teachers (M = 3.60) reported higher perceptions than administrators (M = 3.16), t = -4.283, p < .001. Additionally, readiness and motivation for teachers showed a statistically significant difference between the two groups, with teachers (M = 3.70) reporting higher levels than administrators (M = 3.27), t = -4.479, p < .001. However, for readiness and motivation for students, although teachers (M = 3.52) reported slightly higher perceptions than administrators (M = 3.31), the difference was not statistically significant (t = -1.898, p = .060).

These findings suggest that teachers tend to perceive the factors supporting the implementation of smart learning management more positively than administrators, with statistically significant differences observed in most factors except for student readiness and motivation.

DISCUSSION

The results of this study identify five key dimensions associated with the implementation of smart learning management in the practical project carried out in schools across four provinces in Thailand, as follows:

Policy and Promotion Support

The findings highlight the importance of policy and promotional support in facilitating the implementation of smart learning management in schools. In particular, strategic planning, continuous evaluation, and consideration of contextual factors are perceived as important elements in supporting the development and sustainability of smart learning initiatives. The present findings are largely consistent with Giattino and Stafford's (2019) argument on governance for learning ecosystems, which conceptualizes learning ecosystems as organized structures requiring coordination among stakeholders, processes, and support systems rather than simple technological implementation. They also emphasize the importance of aligning learning technologies, learning science, and broader organizational support structures. Furthermore, they argue that effective governance involves identifying stakeholders, defining issues, developing and coordinating a charter, and ensuring administrative responsiveness. However, while Giattino and Stafford (2019) present a conceptual, system-level governance framework, the present study provides empirical evidence of how these governance-related factors are perceived by school respondents in the day-to-day management of smart learning initiatives.

Moreover, these findings generally also align with those reported by Duffy et al. (2025), although the two studies differ in their specific focus and emphasis. Duffy et al. (2025) contend that school exclusion policy in Northern Ireland is limited by outdated policy documents, a policy approach that is excessively legalistic and procedural, and the lack of a unified framework. As a result, they advocate for clearer and more explicit policies, stronger support for schools, and guidance and training grounded in evidence. The similarity between the two studies lies in their common view that school-level improvement cannot rely on isolated actions alone but instead requires clear policy guidance and effective institutional support. However, while Duffy et al. (2025) examine weaknesses in policies related to school exclusion, the present study considers policy as a facilitating factor in the implementation of smart learning management. Overall, both studies support the argument that educational initiatives are more likely to be effective when schools operate within policy frameworks that are coherent, responsive, and informed by evidence.

In addition, educational policies should be designed to support students' learning readiness, ensuring they stay focused. This helps students improve their learning, maintain punctuality, complete tasks efficiently, and gain meaningful experiences that benefit both their personal growth and the broader community (Nuniek Rahmatika, 2020). To effectively manage educational processes in secondary schools, a clear management system is necessary. It should outline the roles, responsibilities, and guidelines for content management, teaching methods, digital technology usage, and problem-solving. Establishment of evaluation criteria is essential for assessing educational outcomes, while schools must ensure their policies and strategies align with national education goals. These frameworks would guide, regulate, and evaluate the effectiveness of educational activities (Põldoja, 2016; Tuamsuk et al., 2023).

Executive Leadership

The findings highlight the important role of executive leadership in supporting the implementation of smart learning management in schools. In particular, school leaders' vision, openness to innovation, and recognition of the value of digital learning initiatives are perceived as key elements that support the development of smart learning practices. These results are consistent with previous studies. For example, the findings of Öznacar and Parlaktepe Gaziler (2017) indicated that school executives effectively set and communicate school goals but may lack sufficient knowledge in managing educational programs. They support teachers' professional development and collaborate with the social environment to enhance motivation and establish a structured learning atmosphere. Additionally, they demonstrate effective leadership in overall school management. In addition, the principals' leadership practices were guided by their religious beliefs, values, and morals, which reinforced their responsibility to ensure the well-being of all school community members in a diverse, multicultural environment. Their coordination skills and commitment to capacity building played a crucial role in successfully implementing school health initiatives, highlighting the need for leadership training that emphasizes health promotion at the school level (Sasaki et al., 2024). Vanlommel et al. (2025) also emphasized that executive leadership plays an important role in effective leadership during times of change, requiring leaders to recognize and manage paradoxes and tensions constructively. In addition, leaders focused more on supporting and guiding people through challenges, addressing personal difficulties, and maintaining the quality of existing programs, rather than improving the instructional program itself.

Furthermore, He et al. (2024) highlighted a strong link between school principals' instructional leadership and teachers' motivation, identifying key leadership facets that influence professional development. To enhance educational effectiveness, principals must go beyond administrative tasks to strategically foster teacher growth, implement development initiatives, and shape a clear institutional vision. Polatcan et al. (2025) identified teachers' trust in the principal as a significant moderating factor, indicating that greater trust enhances the connection between cultural values and expectations for paternalistic leadership. These findings offer valuable insights into the cultural and psychological dynamics within schools, particularly highlighting how individual cultural orientations and trust levels shape teachers' preferences for paternalistic leadership from their principals. Moreover, the findings of Even and BenDavid-Hadar (2025) found that school principals perceived as transformational leaders significantly improve student performance, particularly in special education needed students, by enhancing teacher satisfaction and student commitment.

Technology and Digital Learning Environments

The findings suggest that effective smart learning management depends largely on schools' readiness to integrate digital technology through strategic planning, clear instructional guidelines, and reliable internet infrastructure. These results indicate that building a supportive digital environment and structured technology use is considered more critical for smart learning implementation than simply providing technological devices. Thus, the findings of this study supported previous research noted that the application of technology in educational settings brings a variety of benefits for teaching and learning. For example, Zheng et al. (2016) mentioned that one-to-one laptop programs can transform classroom practices by increasing technology use for learning and improving academic achievement. However, they require teachers to redesign teaching methods and students to adjust to new, more individualized and student-centered approaches, such as project-based learning, where teachers act as facilitators and students take more responsibility for their learning. The new collaborative environment leverages ICT to provide both asynchronous and synchronous communication tools, enhancing smart classroom experiences. The system integrates sensors, smart devices, software, and real-time services, digital media, utilizing videoconferencing, VoD streaming, a cloud management system, and a gateway to connect various technologies. These elements play a crucial role in enhancing the learning experience (Osmani & Tartari, 2024; Zuhri et al., 2024).

The results of Shen et al. (2024) revealed that school support influences teachers' technology integration only when perceived by teachers as a mediator, with ICT self-efficacy also playing a partial mediation role. These findings emphasize the importance of a supportive school environment and teachers' perceptions in fostering effective technology integration, contributing to the development of strategies for enhancing school

support and teacher readiness. Other studies also mentioned the important roles of other technologies in teaching and learning, highlighting the transformative potential of technologies like metaverse, ugmented reality (AR), and virtual reality (VR) in education. For instance, Metaverse technology offers a valuable tool for enhancing science education, improving student performance, and positively shaping attitudes towards learning environments (Al-Muqbil, 2024). Similarly, the implementation of AR has demonstrated beneficial effects on students' vocabulary learning, self-efficacy, and personality traits, providing insights for innovative instructional approaches and curriculum design, especially in language education (Khodabandeh & Mombini, 2024). Furthermore, the system quality of VR technology plays a critical role in influencing task-technology fit and perceived usefulness, which can enhance learning efficiency (Puiu & Udriștioiu, 2024).

Readiness and Motivation for Teachers

The results of this study suggest that teacher readiness for smart learning is strongly supported by encouraging the effective use of technology in teaching, particularly to enhance students' understanding and support active and experiential learning approaches. In addition, continuous teacher training, clear instructional objectives, and regular monitoring of technology use are considered important factors in strengthening teachers' capacity to implement smart learning effectively. These findings also consolidate the results of Syofyan et al. (2024) who mentioned that teacher readiness plays a vital role in the effective implementation of the curriculum in schools. Success depends on teachers' deep understanding of its principles, goals, and strategies, allowing them to create meaningful learning experiences. Sufficient educational resources, including classrooms, technology, and teaching materials, facilitate innovative teaching methods. In addition, continuous training and professional development help teachers adapt to curriculum changes and refine their skills. Thus, support from school leadership, colleagues, and the community further boosts teacher motivation and promotes an inclusive learning environment. With these elements in place, the curriculum can be implemented effectively, enhancing both teaching quality and student achievement.

The findings of Gaganao et al. (2022) mentioned that teachers are prepared for e-learning, particularly in technical skills, attitude toward online learning, and time management. However, their experience with online teaching and learning remains limited. Meanwhile, Zegeye (2022) studied 80 teachers and found low readiness for teaching in inclusive classrooms, with teaching experience influencing perceptions more than gender or grade level. A lack of adequate training and insufficient preparation in teacher education programs were identified as key barriers. Thus, to enhance their readiness, it is recommended that they engage in training, workshops, and seminars to gain more hands-on experience and ensure effective e-learning implementation (Gaganao et al., 2022).

In addition, Genie Dessie (2024) indicated that teachers showed limited readiness to alter their teaching strategies. Additionally, a statistically significant correlation was identified between teachers' willingness to change and their participation in continuous professional development. The results further suggest that continuous professional development experience is a key determinant of teachers' adaptability to change. Consequently, school leaders, policymakers, the government, and the educational office should take necessary actions to foster a culture that enhances teachers' readiness for change.

Readiness and Motivation for Students

The findings show that students' preparedness for smart learning is closely linked to their access to appropriate digital learning resources and the development of motivation to engage in technology-supported learning activities. In addition, fostering student participation and creating a collaborative learning environment are considered important in supporting effective interaction and engagement within smart learning contexts. Previous studies mention that preparation of students with digital resources and promoting motivation are key factors in enhancing smart learning. Additionally, fostering a collaborative learning environment and encouraging participation in technology-based activities were also important. These findings are in line with the results of previous studies, which mentioned that technology readiness plays a crucial role in shaping the learning outcomes of students in the new normal era. Being prepared with the necessary digital resources, platforms, and devices enables students to effectively manage their learning process, ultimately leading to improved academic performance (Maryani et al., 2023; Tang et al., 2021). In

addition, Nguyen et al. (2023) mentioned that a positive learning atmosphere boosts student motivation and competence through interactive activities, technology use, and real-life connections. The teachers could enhance engagement with discussions, teamwork, and digital tools, making learning more enjoyable and relevant. Moreover, teaching and learning support, including technology, content, infrastructure, and administration, are essential for organizing education, fostering learning communities, and creating active learning environments (Benita et al., 2021; Nguyen et al., 2023; Väljataga et al., 2020).

Cheung et al. (2021) emphasized that the education landscape is transforming with new concepts and technological progress, bringing challenges to smart learning environments. A major focus is the transition to personalized and adaptive learning, which demands innovative teaching methods and smart technologies to support student growth. Enhancing emotional and social engagement in digital spaces is crucial, as affective interaction is often limited. Traditional assessment methods must be updated, with a shift toward formative assessments that promote active learning. The integration of formal and informal learning is vital for fostering independent learning. Additionally, effectively utilizing learning data while maintaining privacy and ethical standards remains a key challenge, requiring advanced learning analytics to improve education.

CONCLUSION

This study examined key factors associated with the implementation of smart learning management in schools participating in the SLIRC project at KKU, Thailand.

The results highlighted the pivotal role of executive leadership in shaping and guiding the educational process. Teachers' readiness and motivation, along with student engagement and supportive policies, also emerged as essential contributors to effective implementation. However, the technology and digital learning environment appeared to be areas requiring further development. Despite strengths in leadership, ongoing efforts are necessary to improve technology integration, enhance student participation, and strengthen teacher support to create a more dynamic and effective learning experience.

This study highlights several limitations that need to be considered when interpreting the findings. First, the sample size was limited, with data collected from only 151 questionnaires, which included 72 responses from school administrators and 79 from teachers. This sample may not be fully representative of the entire population of school administrators and teachers across Thailand, potentially limiting the generalizability of the results. Second, the data collection method relied solely on questionnaires, which while effective for gathering specific feedback, may not have provided a comprehensive understanding of participants' expectations, opinions, and experiences related to smart learning management. Third, all variables in this study were measured using self-report questionnaires administered at a single point in time. This approach may increase the possibility of common method bias, as responses may be influenced by similar response patterns or subjective perceptions. Thus, a more in-depth approach, such as interviews or focus group discussions, could have offered richer insights into the nuanced perspectives of the participants. These limitations suggest that future research should consider broader and more diverse sample groups, as well as incorporate a variety of data collection methods to capture a more holistic view of the factors influencing smart learning management in schools. In addition, Future research may therefore consider employing multiple data sources, mixed-method approaches, or longitudinal designs to reduce potential bias and provide a more comprehensive understanding of smart learning management implementation in schools.

The implications of this study are significant in shaping the landscape of smart learning management in education at four provinces in Thailand. By identifying key factors such as executive leadership, teacher and student readiness, and robust policy support, the research provides actionable insights for school administrators, policymakers, and educators striving to enhance learning outcomes in a technology-driven environment. The findings underscore the importance of a strategic approach to integrating technology into the classroom, promoting not only student engagement but also improving educational effectiveness and sustainability in selected schools. Furthermore, this study contributes to existing literature by offering a framework that emphasizes the interplay between various key factors, ultimately fostering a culture of continuous improvement and innovation in educational settings. As schools look to adopt and refine smart learning initiatives, the research serves as a valuable reference for designing targeted interventions and

developing a holistic understanding of how to effectively implement smart learning practices in diverse educational contexts.

Based on the findings of the study, several recommendations can be proposed to further enhance the implementation of smart learning in selected schools in four Thai provinces. First, schools should further develop their technological infrastructure by improving internet access, upgrading learning platforms, and increasing the availability of digital tools that facilitate teaching and learning. Thus, future research could investigate the following question: How does the standard of technological infrastructure influence the effectiveness and long-term sustainability of smart learning management? Second, schools should offer ongoing professional development opportunities to support teachers in building their technological skills, self-confidence, and pedagogical competence in technology-based instruction. This also suggests an important question for further study: To what extent does ongoing professional development enhance teachers' readiness and performance in implementing smart learning? Third, greater attention should be given to promoting student engagement through collaborative, interactive, and problem-based learning activities that make meaningful use of digital tools. Accordingly, future studies may address the question: How do technology-enhanced learning activities affect students' engagement, motivation, and academic outcomes in smart learning settings? These recommendations offer practical guidance for both schools and policymakers while also identifying useful directions for future research, increasing the study's academic relevance, and encouraging further exploration of the factors shaping smart learning management across different educational contexts.

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Ethics declaration: This study was approved by the Ethics Committee at KKUrsity with approval number HE673368. All participants were provided with information regarding the study's purpose, the voluntary nature of their involvement, and the use of the collected data for academic research purposes. Those who agreed to participate in the project were invited to complete the questionnaire. The study did not collect any sensitive personal data or information that could directly identify participants, including names, identification numbers, addresses, or contact details. All responses were kept confidential, coded, and analyzed only in aggregated form. The collected data were securely stored in password-protected files and were accessible only to the research team. This study was approved by the Ethics Committee at KKUrsity with approval number HE673368.

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